Rare Earth Elements in Kuznetsk Coals: Ability to Excavate and New Functional Materials

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Abstract: The possibility of excavation of valuable rare earth elements (REE) from coals and excavation of ash dumps on the analysis of their content in Kuzbass is examined and discussed. New functional materials on the bases of REE compounds are presented.

Keywords: Kuznetsk coals, ash and slag waste, rare earth elements, functional materials.

1.Introduction

Rare earth elements (REE) are an essential resource for the creation and development of modern high-tech industries; and in accordance with the requirements of scientific and technological progress the steady growth of production and consumption of rare earth metals is observed in the world. Elements of IIIV-group of the periodic table, scandium, yttrium, lanthanum, and 4f-elements (lanthanides) are used in electronics, instrumentation, mechanical engineering, nuclear engineering, metallurgy, chemical industry. REE market outlets are divided into two segments: the undivided metals used in the manufacture of mish metals (rechargeable batteries), putty powders, glass, catalysts and additives for the petrochemical industry; the individual elements used to prepare luminophores, magnets, ceramic condensers, catalytic filters – converters of exhaust gases, small electronic devices, and for many other purposes. Thus, REE are the future of metals .

In Russia, there are at least 17-20% of REE world reserves (the second place in the world), but extraction of raw materials is only about 2% of the world production; and without the implementation of new projects it will fall below 1.5% in the nearest future. Manufacturing with rare earth metals is less than 1% in Russian. It is obvious that the production of rare earth elements is the most important task of our economy.

Coal, being one of the most exploited natural energy source, now is simply burned, at the best before burning coal is exposed to simple mechanical preparation. The traditional use of coal threatens the ecology of the region: the territory of the Kemerovo region is being overloaded by coal combustion wastes, annually 150-160 million tons of these wastes are produce.

Coal should be considered as a complex raw material, which contains valuable chemical elements. Bottom-ash masses of coals are independent ore deposits located on the surface and they do not require expenses for their extraction. Studies have shown [1-5] that in Kuzbass coals there are a large number of sites containing industrially significant concentration of rare earth metals. Sludge discharges of Kuzbass coal-preparation plants remain unexamined for metals, including rare earth metals [2]. The development of high-selective technologies to extract REE from all possible sources and creation of new functional materials on their basis are important tasks both from economic and environmental point of view.

2.Characteristic of the work

REE are extremely characterized by being combined in natural objects, due to the similarity of their chemical properties because of the proximity of their atomic radii as a result of "lanthanide (4f) compression." Preparation of rare earth metals from ores is produced by means of hydrometallurgy methods, electrolysis and by metallothermic reduction. Extraction of individual REE is produced by ion exchange and extraction.

The main method of coals primary processing and ash and slag waste processing is their development by chemical acidic reagents, in the quality of which mineral acids or organic base-exchange substance in the H^+-form and subsequent processing of leaching solutions are used. Nitric acid was used as the reactant for raw material development. Extraction was done by a well-known butyl phosphate which is highly selective to the rare earth metals. In this case the main macro-impurities (salts of aluminum, calcium, iron) serve as the salting-out agent for rare-earth elements extraction. Extraction by organic amides and sulfoxides is tested. The nitrates and oxides of rare earth metals are used for the direct synthesis of double-complex compounds. The study of their structure by X-ray analysis has established the possibility to get both ionic and polymeric compounds [6-8]. The low-temperature technology of a blended (with oxides of transition metal) nanosized oxide powders production and reversible temperature-sensitive materials production was developed on the based of the investigation of thermal and chemical properties of substances [9, 10].

Heat-sensitive pigments serve as chemical sensors in temperature-sensitive devices, which are used for visual inspection of the thermal regime in various technological processes. The method of temperature indication by means of heat-sensitive substances allows to monitor quickly and accurately and in some cases to regulate the temperature fluctuations over a wide range, there is no need in expensive operations and complex instrumentation; the method allows to measure the temperature of the hard-to-get surfaces of any shape and size, the method is suitable for the direct measurement of the temperature field and distribution of thermal loads. The developed heat-sensitive compositions are characterized by the following properties:

- bright color of pigments and clear transition temperatures;
- the ability to change many times the color at the definite temperature, the range of the temperature change depends on the composition and covers the area from 45 to 220 ºC;
- the storage stability of a long period of time and thermal stability under conditions of usage;
- the lack of components, having toxicity and aggression toward the surface of the tested material;
- solubility in organic solvents and indifference to the most commonly used fillers and fixants;
- the durability of the heat-sensitive coating.

In Russia, there is currently no mass production of color temperature indicators, which meets modern requirements of science and technology.

3.Conclusion

Rare earth metals are one of the raw materials of rapidly developing high-tech industry. REE industry is developing towards closed economy, in which the raw material is recycled more than once and used again. Considering the ash and slag, slimes and coals of Kuzbass as a valuable raw material for their complex processing, it is necessary to develop and to improve extraction technologies, in particular, extraction technologies of expensive REE; it will significantly improve the profitability of coal industry by means of rare metals production and production of functional materials based on them. Furthermore, the complicated ecological situation in the Kemerovo region, which is overloaded by waste from coal enterprises, makes the problem of deep processing of raw materials in order to improve the quality of life in the region particularly urgent.

4.References

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